THE SOUTHWESTERN NATURALIST 24(4):603–612 DEC. 10, 1979

NOTES ON INSECTS ASSOCIATED WITH DESERT BROOM (*BACCHARIS SAROTHROIDES* GRAY) (COMPOSITAE) IN SOUTHEASTERN ARIZONA

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ABSTRACT. Insects were collected from the foliage and branches of Desert Broom (*Baccharis sarothroides* Gray) at three locations in southeastern Arizona from mid-July to early September in 1976 and 1977. The interrelationships among 25 species collected from *B. sarothroides* included taxa involved with mimetic assemblages, predator defense, and concealment. Observational data also are presented on the utilization of *B. sarothroides* and the behavior of both rare and common species collected concurrently from broom during each visit.

Approximately 300 species of *Baccharis* occur in the western hemisphere, with the greatest species diversity represented in eastern South America (Munz 1959). One species, *B. sarothroides* Gray (desert broom) (Fig. 1), is a distinctive desert shrub which is commonly associated with both Upper and Lower Sonoran ecosystems (300-1650 m elevations) in Cochise and Santa Cruz counties, Arizona (Kearney and Peebles 1960, D. J. Pinkava pers. commun.). During the summer months (July-September), the "broom-like" foliage and resinous exudate found on the branches are utilized by a diversity of insect species for either shelter or food. Although this species has been reported to be toxic to cattle and other bovids (Kearney and Peebles 1960), it does not appear to be toxic to insects.

METHODS. During three visits to Cochise and Santa Cruz counties (16-25 July 1976, 1-9 September 1976, and 19-27 August 1977), approximately 500 *B. sarothroides* bushes were searched for insects representing both mimetic and cryptic assemblages which included species considered either rare or unusual by collectors. Samples were taken from plants growing along roadsides (Fig. 1) and washes at Tombstone Canyon (Mule Mts.), Cochise Co., R24E, T23S; Madera Canyon (Santa Rita Mts.), Santa Cruz and Pima co.'s R14E, T20S; Patagonia (Sonoita Cr.), Santa Cruz Co., R16E, T22S; and Tombstone, Cochise Co., R22E, T20S. The frequency of each insect species occurring on the plants inspected was rated as either common ($>$ 1 per plant), occasional, or rare ($<$ 1 per 50

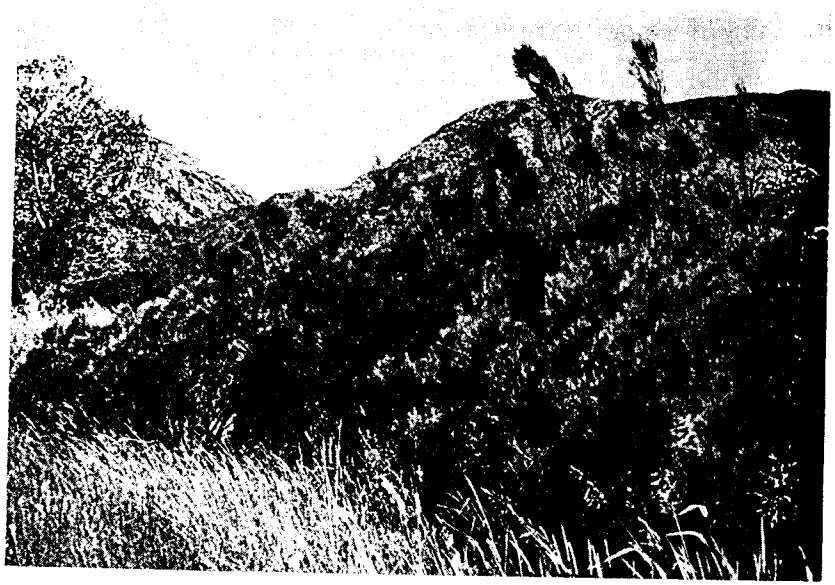

Fig. 1. Typical form of desert broom (*Baccharis sarothroides* Gray) in Tombstone Canyon. Plants in the right foreground are approximately 2 m tall. Note the dense crown foliage and exposed stems.

plants). The portion of the plant, either crown foliage (stems) or branches, normally inhabited by each species was noted at the time of collection. Furthermore, as little is known on the bionomics of many of these species, we took both ecological and behavioral notes on those species which congregate on broom during the summer rainy season.

RESULTS AND DISCUSSION. At least 25 species representing seven orders were collected from *B. sarothroides* at four locations in southeastern Arizona (Table 1). Since no plants were blooming when collections were taken, information on pollinator species was not available. All material has been deposited in the insect repository at the University of California, Davis (U.C. Davis).

Most species aggregated on specific plants, not at random among the many plants examined. Although physical similarities among these plants were not obvious, most were characterized by very dense foliage and/or copious amounts of resinous exudate accumulated on the branches. Aggregations were typical for all locations, with some plants being unoccupied or yielding only a few specimens.

The species collected were classified into 1) Batesian assemblages, 2) cryptic forms, and 3) non-mimetic or non-cryptic forms. A significant number of species represented in the latter group were aposomatically colored and often possessed repellent systems or stingers to discourage predation.

Batesian Assemblages.—Studies on mimetic systems involving Batesian assemblages have been well presented by Linsley et al. (1961) for *Lycus* associations in southeastern Arizona. Although neither *Lycus* nor related mimetic species were collected from *B. sarothroides*, eight species representing three distinct Batesian assemblages were found on broom, especially in Tombstone Canyon (12 km E Bisbee).

Group 1: During routine inspections of broom growing beside the highway in Tombstone Canyon, adults of *Climaciella brunnea* (Mantispidae) and *Thyreodon fernaldi* (Ichneumonidae) were mistaken for two vespids occurring sympatrically, *Polistes canadensis navajoe* and *Polistes canadensis canadensis*, respectively. Integumental and wing coloration of both mimics is similar to that of their respective models. Both *C. brunnea* and *P. c. navajoe* are dark reddish–brown with yellow markings, while *T. fernaldi* and *P. c. canadensis* are concolorous dark reddish-brown. In addition, mimics rest with their wings held in an oblique angle to the body and thus appear like *Polistes* in habit. Although *P. c. navajoe* and *P. c. canadensis* were common at the other locations visited, associations of *C. brunnea* and *T. fernaldi* were not observed at Madera Canyon, Patagonia, or Tombstone.

Group 2: Adults of *Tragidion annulatum* (Cerambycidae), which resemble red-winged *Pepsis* spp. (Pompilidae) (Linsley 1962), were collected from large, densely foliated plants where the model (*Pepsis* spp.) was commonly observed "gleaning" the main branches or feeding on resinous exudate on the main branches. Associations of *T. annulatum* and *Pepsis* were occasional on the broom in Tombstone Canyon and less frequent at Tombstone. The association was not observed at either Madera Canyon or Patagonia, though *Pepsis* was present. A review of specimens deposited in the U.C. Davis collection indicated a number of records of both species from Madera Canyon and Patagonia. Linsley (1962) reported the host plant of *T. annulatum* as *Baccharis sergiloides* Gray. Both *B. sergiloides* and *B. sarothroides* are sympatric in some areas, with the latter the more common species (D. J. Pinkava pers. commun.). Differences in abundance of *B. sergiloides* associated with discrete habitats relative to

TABLE 1

Classification, location, occurrence, and microhabitat association of the insect species collected from B. sarothroides *in Cochise and Santa Cruz Counties, Arizona. Symbols* — Location: *MC = Madera Canyon, P = Patagonia, TC = Tombstone Canyon, T = Tombstone;* Occurrence: *CM = common, O = occasional, R= rare;* Microhabitat: *CF =crown foliage, B = branches.*

Taxon	*Location*	*Occurrence*	*Microhabitat*
Batesian assemblages			
Group 1:			
Neuroptera			
Mantispidae			
Climaciella brunnea (Say)	TC	C	CF
Hymenoptera			
Ichneumonidae			
Thyreodon fernaldi Hooker	TC	O	CF
Vespidae			
Polistes canadensis canadensis Cameron	MC, P, TC, T	C	CF, B
P. c. navajoe Cameron	MC, P, TC, T	C	CF, B
Group 2:			
Coleoptera			
Cerambycidae			
Tragidion annulatum LeConte	TC, T	O	CF, B
Hymenoptera			
Pompilidae			
Pepsis spp.	MC, P, TC, T	C	CF, B
Group 3:			
Coleoptera			
Cerambycidae			
Dendrobias mandibularis mandibularis Audinet-Serville	MC, P, TC, T	O	CF, B
Scarabaeidae			
Euphoria fascifera LeConte	TC	R	CF
Cryptic species			
Green:			
Coleoptera			
Elateridae			
Chalcolepidius behrensi Canad.	MC	O	CF, B
Cerambycidae			
Philinthoccelium suaveolens plicatum LeConte	TC	R	CF
Scarabaeidae			
Cotinis mutabilis G. & P.	MC, P, TC, T	O	CF, B
Euphoria holochloris Fall	P, TC	O	CF
Red-brown and/or gray:			
Coleoptera			
Tenebrionidae			
Metaloba sp.	MC, P, TC, T	C	CF
Polemiotus submetallicus LeConte	MC, P, TC, T	C	CF
Scarabaeidae			
Euphoria testacea G. & P.	MC, P, TC, T	C	CF
Lepidoptera			
Libytheidae			
Libythea bachmanni Kirtland	MC, P, TC	O	B
Nymphalidae			
Asterocampa leilia cocles Lintner	MC, P, TC	C	B

TABLE 1—Continued

Taxon	Location	Occurrence	Microhabitat
Non-cryptics and non-mimetics			
Group 1:			
Orthoptera			
Acrididae			
Taeniopoda equis Burm.	MC, TC, T	O	CF, B
Hemiptera			
Coreidae			
Acanthocephala granulosa Dallas	MC, P, TC, T	C	CF, B
A. thomasii Uhler	MC, P, TC, T	O	CF, B
Coleoptera			
Cerambycidae			
Stenaspis solitaria Say	MC, P, TC, T	C	CF, B
Hymenoptera			
Vespidae			
Polistes flavus Cresson	MC, TC	C	CF, B
Sphecidae			
Chlorion aerarium Patton	MC	C	CF, B
Prionony x fervens (L.)	MC	O	
Group 2:			
Orthoptera			
Acrididae (several spp.)	MC, P, TC, T	C	CF, B
Homoptera			
Fulgoridae			
Poblicia fuliginosa Oliva	P, TC, T	C	CF
Hymenoptera			
Chalcidae			
Acanthochalcis nigricans Cameron	MC	C	CF

exploitation by *T. annulatum* may explain the absence of these beetles on *B. sarothroides* where the latter species is less common. Collections, however, were taken exclusively from *B. sarothroides* at all locations.

Group 3: Specimens of *Euphoria fascifera* (Scarabaeidae) were collected from the crown foliage of the broom in Tombstone Canyon in association with *Dendrobias mandibularis mandibularis* (Cerambycidae). Adults of *D. m. mandibularis* were commonly collected independent of *E. fascifera* from broom at the other areas visited. Adults of *E. fascifera* exhibit bright orange elytra patterned with three distinct and evenly spaced black cross bands and were easily mistaken for *O. m. mandibularis*, even though representatives of the proposed model have but two black cross bars, one at the base and one at the mid elytral position (Linsley 1962). Although aposomatically colored black and orange, a pattern that is not suggestive of *Pepsis*, the palatability of *Dendrobias* and other North American Cerambycidae has not been thoroughly investigated (S. S. Duffey, pers. commun.). Until palatability is demonstrated in the model, the Batesian relationship between *D. m. mandibularis* and *E. fascifera* remains tentative.

Cryptic Species.—We observed that the coloration and integumental patterns of certain species aided concealment when on either the green or brown and gray vegetative elements that are typical of broom. Those cryptic species collected from crown foliage and at the base of main branches which supported new growth were usually patterned or shaded green, while those collected more frequently from the branches were patterned reddish-brown and gray. Exceptions included *Chalcolepidius behrensi* (Elateridae) and *Cotinis mutabilis* (Scarabaeidae). Both were colored green and occasionally inhabited sites on the main branches.

Green cryptics: A most striking discovery was the presence of *Plinthocoelium sauveolens plicatum* (Cerambycidae) on broom growing in Tombstone Canyon. Linsley (1964) reported this ornate, metallic green species breeding in Chicle (*Bumelia languinosa rigida* Gray.) Chicle was present at Tombstone Canyon near the broom from which four males were collected in mid August 1977. Interestingly, all specimens were found at the base of large plants that supported new, bright green growth. When collected, each male ejected a noxious fluid from between the pronotum and the base of the elytra and mesothorax. The function and composition of this fluid as well as

that of *Stenaspis solitaria* (Cerambycidae) has not been reported, though it may function as a predator defense in the latter (Linsley 1962).

Particularly well adapted for concealment were the adults of *Euphoria holochloris* (Scarabaeidae), collected occasionally from the broom in Tombstone Canyon and along Sonoita Creek (5 mi SSW Patagonia). The small size and green to blue-green coloration of this species made the discovery of specimens difficult when hidden by the crown foliage. Accordingly, many adults were likely overlooked.

Associations of *C. mutabilis* and *C. behrensi* were common on broom during the early summer. When we revisited the same plants growing in washes at Madera Canyon in August and September, no *C. behrensi* and a few *C. mutabilis* were present. At the same location during mid-July, adults of *C. behrensi* were also collected from nearby mesquite, *Prosopis juliflora* (Swarz). Unlike *C. behrensi*, collections of *C. mutabilis* were taken from broom at the remaining locations.

Reddish-brown and/or gray cryptics: This large group of cryptics consisted of five species, including the butterflies *Libythea bachmanni* (Libytheidae) and *Asterocampa leilia cocles* (Nymphalidae), two species of darkling beetles (Tenebrionidae) *Metaloba* sp. and *Polemiotus submetallicus*, and *Euphoria testacea* (Scarabaeidae).

Adults of *L. bachmanni* and *A. l. cocles* have the undersides of the wings patterned in reds, browns, and grays. With the wings folded, the pattern and coloration provided concealment for individuals resting on the main branches in the shaded portions of large plants. During mid-July at Madera Canyon, aggregations of *A. l. cocles*, usually consisting of three to five individuals, were observed feeding upon the resinous exudate of larger branches. Feeding aggregations were less common in *L. bachmanni*, and none was observed for either species in August or September.

Specimens of *Metaloba* sp. and *P. submetallicus* were commonly taken from broom at all locations with the exception of the few collected from plants in Tombstone Canyon. Although less cryptic than the other species in this group, adults were generally well concealed when resting on main branches surrounded by crown foliage.

Of the cryptic forms taken from *B. sarothroides*, the most common species collected was *E. testacea*. Adults were sometimes numerous on select plants growing along roadsides in all locations. On several occasions, more than 10 individuals were taken from a single plant along roads near Tombstone and Patagonia and in washes at Madera and Tombstone canyons. Similar to the green colored counterpart, *E. holochloris*, the color and elytral markings of this species closely resembled the texture and color of the branches.

Non-Cryptic and Non-Mimetics.—Species comprising the majority of those collected from broom and not considered as either mimetic or cryptic were placed in this last group. These insects can be further characterized as 1) species that possess chemical repellents or stingers and 2) species without these apparent defense mechanisms.

Group 1: Several different species of short-horned grasshoppers (Acrididae) were observed resting in the crown foliage; however, only one colorful species (*Taeniopoda equis*) was collected (Table 1). Adults are strikingly marked yellow on black, and the hind wings are a brilliant pink and indicate possible warning coloration in this species that is perhaps related to unpalatability. Both adults and mature nymphs were common in early September, especially in open areas or on broom near Tombstone and in Tombstone Canyon.

Two large coreids, *Acanthocephala granulosa* and *A. thomasii* (both dark brown with red antennae), and the cerambycid, *Stenaspis solitaria* (unicolorous shiny black), were common on broom throughout Cochise and Santa Cruz counties, with the exception of *A. thomasii*. Both nymphs and adults of *A. granulosa* and *A. thomasii* were encountered, at times abundantly on broom growing in washes rather than along roadsides. Specimens of *S. solitaria* were rarely encountered singly, but rather in congregations of three to six individuals on select plants in association with *D. m. mandibularis*.

During mid-July at Madera Canyon, we observed the adults of *Chlorion aerarium* and *Prionony x fervens* (both sphecids), and *Polistes flavis* (a vespid) on broom growing abundantly in bajada washes 14 km SSE Continental. Females of both species would frequently fly from plant to plant and methodically glean the main branches, while usually avoiding the crown foliage. Unfortunately, no females were seen leaving these plants carrying prey. The more common *P. flavus* (bright yellow) was often found associated with the previously mentioned species, *P. c. canadensis* and *P. c. navajoe*. All three wasps would occasionally congregate at sites of resinous exudate that were also inhabited by *E. testacea*, *C. mutabilis*, and *A. l. cocles*. On plants without significant amounts of exudate, we found only a few isolated specimens of *A. granulosa*, *A. thomasii*, and *C. brehensi*.

Adults of the large chalcid *Acanthochalcis nigricans* were collected from the upper branches and crown foliage of large plants at Madera Canyon and Patagonia, though occasional specimens were taken at the other locations. Adults were generally more active during the morning, and were observed circling around the tips of the crown foliage. Cameron (1884) indicated this species to be a possible parasite of *Chrysobothris femoralis* (Oliver) (Buprestidae). None of these was seen on *B. sarothroides*.

Specimens of *Poblicia fuliginosa* (Fulgoridae) were commonly taken from broom in Tombstone Canyon and around Tombstone. The black adults were readily visible in the crown foliage, but were somewhat difficult to collect. Plants inhabited by this species generally did not yield a diversity of other insect species, but occasional associations of grasshoppers, *E. testacea*, *S. solitaria*, or *D. m. mandibularis*.

The authors wish to thank the following individuals for their support and contributions: Dr. R. M. Bohart for reviewing this manuscript, Mr. R. O. Schuster for helping with the determination of some insect species, and Dr. D. J. Pinkava and Dr. S. S. Duffey for providing technical information.

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THE SOUTHWESTERN NATURALIST 24(4):613–620 DEC. 10, 1979

THE EFFECTS OF ADDED WEIGHT ON WALKING SPEEDS IN *ORCONECTES VIRILIS* (DECAPODA: ASTACIDAE)[1]

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ABSTRACT. Tests were conducted on 18 *Orconectes virilis* (Hagen) crayfish, 8 males and 10 females, to determine the effects of a simulated 5 gram radio-tracking transmitter on their walking speeds. The results were that an overall decrease was observed. Of the 18 tested crayfish, 11 (3 males and 8 females) showed a significant decrease in speed, while 1 female showed a significant increase in speed.

Dispersal, migration (Camougis and Hicher 1959, Mobberly and Owens 1966, Bovbjerg 1956, Momot 1966, and Momot and Gowing 1972) and home range (Black 1963, Merkle 1969, and Hazlett et al. 1974) have received much attention in the field of crayfish biology. However, rates of locomotion remain obscure.

The roles of the different pairs of pereiopods in crayfish feeding and walking have been described by several workers including Lockhead (1961), Manton (1952), and Parrack (1964). Pond (1975) investigated the walking speed of the crayfish *Austropotamobius pallipes* (Lereboullet) as a function of stepping frequency and mean distance moved per step. This work is the most extensive attempt to delineate the walking speeds in any species of crayfish.

This paper compares the walking speeds of the crayfish (*Orconectes virilis*) under laboratory conditions with the walking speeds of the same subjects carrying a weight (5 g) attached to their carapace. The importance of this comparison relates to interpreting ongoing and future studies of crayfish mobility using small radiolocational transmitters that weigh 5 grams.

METHODS AND MATERIALS. Eighteen crayfish (*Orconectes virilis*), 8 males and 10 females, were used for this investigation. The live wet weights were obtained with an analytical balance and recorded to the nearest 0.1 g. Body

[1] Supported in part by National Science Foundation Grant DEB 76–82986.

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